



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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|---------------------------|--------------------------|
| In Re Application of: |) Atty. Docket: TM&K0008 |
| Shinji TAKEDA et al. |) Confirmation No.: 9092 |
| |) |
| Serial No. 09/785,486 |) Group Art Unit: 2827 |
| |) |
| Filed: February 20, 2001 |) Examiner: D. GRAYBILL |
| |) |
| For: SEMICONDUCTOR DEVICE |) |
| AND PROCESS FOR |) |
| FABRICATION THEREOF |) |

DECLARATION UNDER 37 C.F.R. § 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

1. I, KATOI Shigeki, state that I am an expert in the field of semiconductor research and development, and particularly in the field of development of adhesives for semiconductor packages and electronics. I received a Master of Engineering degree from the Tokyo University of Agriculture and Technology in March 1992. I joined the Hitachi Chemical Company Ltd. in April 1992. I have researched photo and thermal curing systems of adhesives used for semiconductor packaging at the Ibaraki Research Laboratory, Hitachi Chemical Company Ltd. for 8 years. Since April 2000, I have been engaged in the development of adhesive tapes for LCD at the Packaging Material Laboratory, Research & Development Center, Hitachi Chemical Company, Ltd.

2. I have authored or co-authored and published, for example, the following papers.

1. S. Katogi, M. Yusa: Journal of Photopolymer Science and Technology, Vol. 14(2), pp. 151-152, 2001.
2. S. Katogi, M. Yusa: Journal of Photopolymer Science and Technology, Vol. 15(1), pp. 35-40, 2002.
3. S. Katogi, M. Yusa: Journal of Polymer Science part A: Polymer Chemistry, Vol. 40, pp. 4045-4052, 2002.

3. I am familiar with the above captioned patent application and understand that certain prior art references were cited against the claims of the application and that there is a question of fact over (a) what is the scope of the subject matter described in the above captioned application that would clearly allow a person of ordinary skill in the art of making adhesives for semiconductor packages to recognize that the inventor invented what is claimed, and (b) does the description of the above captioned application enable a person of ordinary skill in the art to make and use the claimed invention. In addition, while I am familiar with the above captioned application, I am not a co-inventor.

4. The following testimony is believed to be true and correct to the best of my knowledge and belief, and any facts related therein are also believed to be true and correct to the best of my knowledge and belief.

5. **Scope of the Written Description and Enablement**

I have reviewed the above-captioned application, including specification, drawings and claims. I offer the following opinion regarding what I believe the description of the above captioned application clearly allows a person of ordinary skill in the art of making adhesives for semiconductor packages to recognize has been invented by the inventors.

Specifically, the disclosure of the present invention describes a filmy organic die-bonding material that is mainly made of epoxy resin, silicone resin, acrylic resin, or polyimide resin, and may include a metal filler or an inorganic material filler (See specification, page 3, line 20, to page 4, line 5). The purpose of the invention is to provide a filmy organic die-bonding material that has few or no reflow cracks in order to overcome the limitations of prior art materials (See specification, page 3, lines 16-19). From a practical standpoint, the degree of reflow cracking will have an affect on certain properties of the material, such as its adhesive strength characteristics.

The inventors of the present invention partially define their invention in terms of various properties the filmy organic die-bonding material embodiments have, such as saturation moisture absorption, peel strength and residual volatile properties, etc. described on page 5, line 22, to page 10, line 23. I believe that an ordinary person skilled in the art of adhesive development, which is a material science, would know that a material can be described by its various properties because certain similar materials may have very different properties. For example, diamond and graphite are similar materials in that each is formed from carbon; however, these materials have very different properties because they are structural allotropes.

In other words, I believe that a person skilled in the art would know what filmy organic die-bonding materials have been invented on the basis of (i) a description of the properties of the material, and (ii) knowledge of a sufficient number of detailed examples from which to base possession of a class of materials.

In the above captioned application, the inventors have provided a list of tetracarboxylic dianhydrides (see page 11, line 18, to page 14, line 13) that could be used to make a polyimide in accordance with the claimed invention. I believe a person skilled in the art would realize that members of this class of tetracarboxylic dianhydrides, as per the list, would behave similarly. Likewise, the inventors have provided a list of diamines (see page 14, line 14, to page 16, line 20) that can be used to make a polyimide in accordance with the claimed invention. I believe a person skilled in the art would realize that members of this class of aromatic diamines, as per the list, would behave similarly.

The inventors further describe how to make the polyimides for making the films of the present invention by combining one of the listed tetracarboxylic dianhydrides with one of the listed diamines, and subjecting them to a known condensation method, which is also outlined (See page 16, lines 21, to page 17, line 4). The inventors further instruct that the polyimides in accordance with their invention is obtained by subjecting the product of the condensation method to dehydration ring closure (See page 17, lines 5-8). I believe a person of ordinary skill in the art would be able to take these starting materials and subject them to the generally described processes and obtain polyimide films having the claimed properties without undue experimentation especially in view of the specific Examples 1-7 described in the specification between page 18, line 15 and page 36, line 36.

In my opinion, the specific species embodiments provided by polyimides A through F, compiled in Table 1, and as described on page 18, line 15, to page 21, line 20, additionally show that the inventors were in possession of at least six different species of film material. I believe that the description of the above captioned application adequately detailed how to make and use these polyimides sufficiently so as to make adhesive die-bonding films as supported by the described synthesis and the experimental results testing, and characterizing, these embodiments. Furthermore, as a person skilled in the art of making similar adhesive materials, I believe I could make and use, without undue experimentation, other filmy organic die-bonding materials that satisfy the claimed characteristics (i.e., 17-degree peel strength, modulus of elasticity, water absorption, saturation moisture absorption, etc.) when die-bonded under the conditions of 100-250°C temperature and 0.1-30 gf/mm² recited in the claims given the list of starting materials on page 11, line 17, to page 16, line 18, and the methods of synthesis described on page 16, line 19 to page 17, line 8, and on page 18, line 15, to page 19, line 24, of the above captioned application.

I believe that the above captioned specification also clearly allows one of ordinary skill in the art to make other filmy organic die-bonding materials that further include epoxy resin as described on page 17, lines 9-12, which lists four types of suitable epoxy resin classes (i.e., glycidyl ether type, glycidylamine type, glycidyl ester type, or alicyclic type). The species embodiments of Table 1, on page 21 of the present specification, are all made with epoxy resin. Such classes of epoxy resin are well known in the art of making adhesives for semiconductors, and I believe no undue experimentation would be required to apply them to the present invention.

Lastly, I believe a person of ordinary skill in the art would be able to add in various known resins, such as silicone resin and/or acrylic resin (See specification, page 3, lines 20-25), without undue experimentation, to the filmy organic die-bonding materials described in Examples 1-7 of the present specification while maintaining the recited physical properties in accordance with the claimed invention.

In view of the facts discussed above, I believe a person of ordinary skill in the art would recognize that the inventors, of the invention described by the above captioned application, had possession of polyimide containing filmy organic die-bonding materials that satisfied the claimed properties when subjected to the recited die-bonding conditions of 100-250°C temperature and 0.1-30 gf/mm². This scope includes both the particular species embodiments described in Table 1 on page 21, and the genus defined by the at least six disclosed species. In other words, the description provided by the above captioned application would, in my opinion, clearly allow a person of ordinary skill in the art to recognize that the present inventors invented what is claimed in claims 17-19, 21-34 and 37-50 of the above captioned application.

Furthermore, I believe a person of ordinary skill in the art has been shown how to make and use the invention claimed in claims 17-19, 21-34 and 37-50 of the above captioned application for the same reasons.

6. **Peel Strength Test**

The disclosure of the above captioned application describes a "Method of measuring a peel strength" on page 33, lines 1-16, and as illustrated in Figure 2. I believe

that a person of ordinary skill in the art would recognize and understand the “peel strength” described and defined in the above captioned application.

In my opinion, persons of ordinary skill in the art would be aware that there are many different standardized tests for measuring the “peel” strengths of an adhesive as evidenced by the following illustrative standards: (a) “Standard Test Method for Peel or Stripping Strength of Adhesive Bonds” (of record), also known as ASTM Designation: D 903-98; (b) “Standard Test Method for Peel Resistance of Adhesives (T-Peel Test)” (of record), also known as ASTM Designation: D 1876-01; and (c) “Adhesives—Peel test for a flexible-bonded-to-rigid test specimen assembly,” (attached herewith) which discloses a 90° peel strength test known as International Standard ISO 8510-1:1990(E). Each of these standard tests takes an adhesive to be tested and use it to bond a test piece of some sort to a base plate or frame. Then, an increasing amount of force is applied at certain angles (i.e., 90° or 180°) until the adhesive gives way, at which point the amount of force required to effect failure of the adhesive is recorded.

The ASTM Designation: D 1876-01 test and the International Standard ISO 8510-1:1990(E) test are generally classified as “90-degree” peel strength tests because, as shown in the Figures used to define these tests, a force is applied at a 90° angle to the plane containing the adhesive. I believe that persons of ordinary skill in the art would know that 90-degree peel strength tests are designed to test the linear areal strength of the adhesive.

On the other hand, tests such as the ASTM Designation: D 903-98 test, are generally classified as “180-degree” peel strength tests because, as shown in the Figure used to define this test, a force is applied within the plane containing the adhesive (i.e., at a 180° angle). I believe that persons of ordinary skill in the art would know that 180-degree

peel strength tests are designed to test shear strength of the adhesive, and that there is no conversion factor for converting shear strength values to linear areal strength values because these values represent different adhesive properties.

Turning to Figure 2, and page 33, lines 1-16, of the above captioned application as originally filed, it is clear that the peel strength test described therein uses an organic die - bonding material to bond a 5mm x 5 mm test chip to a lead support member. Then, a force is applied using a push-pull gauge so that the force is applied obliquely, along a diagonal direction, across the adhesive film. As shown in Figure 2, the force is applied at an angle of 17° to the plane containing the adhesive. In accordance with industry custom, the test defined and described in Figure 2 would be classified as a “17-degree” peel strength test. In my opinion, the 17-degree peel strength test described by the disclosure of the above captioned application is a test of both shear strength and linear areal strength because the oblique force applied would have two components, one oriented at 90° to the plane of the adhesive and another oriented at 180° to the plane of the adhesive. However, the 17-degree strength test may also test any interactions between shear strength and linear areal strength of the adhesive as well. Consequently, I know of no conversion factor that could be used to convert such oblique or diagonal force measurements of peel strength to either shear peel strength values or linear areal peel strength values.

7. Conclusions

In my opinion, the description provided by the disclosure of the above captioned application is sufficient to clearly allow a person of ordinary skill in the art, such as myself, to recognize that the inventors had invented what is claimed in claims 17-19, 21-34 and 37-

50 of the application. Furthermore, I believe that the disclosure of the above captioned application is sufficient to teach one of ordinary skill in the art how to make and use the invention as defined by claims 17-19, 21-34 and 37-50. This includes both the species claims 39-44 and the independent genus claims 17, 19 and 30. In other words, I believe that the evidence shows that the six species described in the above captioned application defines a genus in possession of the inventors' at the time the application was filed.

Lastly, I believe that the "Method of measuring a peel strength" as defined and described in Figure 2 and on page 33, lines 1-16, of the above captioned application is adequately described so that a person of ordinary skill in the art, such as myself, could perform the test and use it to characterize a certain peel strength for an adhesive, such as a filmy organic die-bonding adhesive. In addition, I believe that a person of ordinary skill in the art would recognize that this test measures the strength of the adhesive when an oblique/diagonal force is applied at 17-degrees to the plane of the adhesive, and that such a test is reasonably characterizable as a "17-degree peel strength test" in accordance with industry custom. I believe it is clear that the "Method of measuring a peel strength" as defined and described in Figure 2 and on page 33, lines 1-16, of the above captioned application is a 17-degree peel strength test that measures 17-degree peel strength of an adhesive bond.

8. I declare under penalty of perjury that the foregoing is true and correct, that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements so made are punishable by fine or

imprisonment, or both, under 18 U.S.C. § 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Signed by,

Date: Apr. 9, 2008

Shigeki Katogi
KATO GI Shigeki



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| Shinji TAKEDA et al. |) Confirmation No.: 9092 |
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DECLARATION UNDER 37 C.F.R. § 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

1. I, MASUKO Takashi, state that I am an expert in the field of semiconductor research and development. I received a Master of Science degree in Environmental Science from the University of Tsukuba in March 1992. I worked in the Tsukuba Research Laboratory, Hitachi Chemical Company Ltd. from April 1992. I have worked in Packaging Material Laboratory, Research & Development Center, Hitachi Chemical Company Ltd. since June 1999. I have been engaged in the development of die attach materials since 1992.

2. I have authored or co-authored and published, for example, the following papers.

1. S. Takeda, T. Masuko: Proceedings of the 1997 Electronic Components and Technology Conference (ECTC), pp. 518-524, 1997.

2. S. Takeda, T. Masuko: Proceedings of the 2000 Electronic Components and Technology Conference (ECTC), pp. 1616-1622, 2000.
3. T. Masuko, S. Takeda: Proceedings of the 9th Micro Electronic Symposium (MES), pp. 249-252, 1999.
4. S. Takeda, T. Masuko: Hitachi Chemical Technical Report, No. 24, pp. 25-28, 1995.

3. I am familiar with the above-captioned patent application and understand that certain prior art references were cited against the claims of the application. Specifically, I am familiar with the Morita et al. reference (U.S. Patent 5,406,124).

4. The foregoing experimental results were collected directly by me, or by others under my direct supervision, and that the experiments were performed with my understanding and knowledge.

5. **Experimental Conditions**

The purpose of this experiment was to compare the closest prior art filmy organic die-bonding material ("prior art film") to the filmy organic die-bonding material of the present invention ("novel film"). Specifically, we utilized the film disclosed by Morita et al. (U.S. Patent 5,406,124) as the closest prior art film and compared the adhesion characteristics (peel strength) and the durability (rate of occurrence of reflow cracks) of the prior art film to the novel film.

6. Prior Art Film

The prior art film was produced using the method described by Morita as "EXAMPLE 1" (column 14, line 60 to column 15, line 2). An amount of 14.6 g (0.05 mol) of 1,3-bis(3-aminophenoxy)benzene and 92.1 g of N.N -dimethylacetamide were introduced into a container equipped with an agitator, a reflux condenser, and a nitrogen pipe. Thereafter, 16.0 g (0.0495 mol) of 3,3',4,4-benzophenonetetracarboxylic acid dianhydride was divided into four portions and added into the container under nitrogen atmosphere at room temperature and the mixture was stirred for 20 hours at room temperature. This process produced a polyimide acid varnish.

Next, a Base film of 50 μm thickness was coated on both sides with the polyimide varnish produced by the previous steps. The coated film was then dried at 100°C for 1 hour followed by drying at 250°C for 1 hour. The result was a three-tiered film having a 10 μm thick polyimide layer (T_g 200°C) corresponding to the prior art film of Embodiment No. 1 of the Morita reference (See Table in Morita reference).

The Embodiment No. 1 of the Table in the Morita reference, which corresponds to the film produced using the method outlined in Example 1 of the Morita reference, was selected to represent the closest prior art. I believe, based upon my experience in the art, that Embodiments Nos. 1 through 24 compiled in Table 1 of the Morita reference would manifest similar areal peel strengths because these examples exhibit only minor differences in the structure of the original materials, the acid anhydride, and the diamine, used to formulate them.

7. Novel Film

The novel film was produced using the method disclosed in the specification as originally filed (page 19, line 13 to page 20, line 21). An amount of 280 g of organic solvent (N-methylpyrrolidone) was added to 100 g of polyimide, specifically identified as Polyimide F in the specification and made from DBTA (1, 10-(decamethylene)bis(trimellitate anhydride)/BAPP(2,2-bis[4-(4-aminophenoxy)phenyl]propane), in 10 g of epoxy resin. The mixture was stirred thoroughly until the mixed solution was homogeneously dispersed. The product of these steps was a coating varnish.

Next, a carrier film (OPP film; biaxially stretched polypropylene) was coated with the coating varnish of the previous step. The coated carrier film was then heated in a dryer with internal air circulation for 30 minutes at a temperature of 80°C followed by 30 minutes at 150°C. This heating process evaporated the solvent and dried the varnish. After drying, the carrier film was removed and the resulting novel film obtained had a thickness of 20 μm . This film corresponds to film No. 8, Table 1, of the specification (page 21) of the above captioned application.

8. Evaluation of Films

(1) Evaluation of film adhesiveness

To evaluate film adhesiveness, the prior art and novel films were cut into 5 x 5 mm sized pieces. Each piece of film was then die-bonded to a 42 alloy lead frame at a temperature of 250°C and a pressure of 120gf/mm² maintained for 5 seconds. Each film was subsequently die-bonded to a 5 x 5 mm silicon chip to form the structure (21, 22, 23) illustrated in Figure 2 of the specification. The experiment was repeated under three

different die -bonding conditions. Table 1 shows the conditions under which 5 x 5 mm silicon chips were die-bonded to the lead frame.

Peel strength, as defined in the above-captioned application, was measured by a push-pull gauge at a test speed of 0.5 mm/minute and oriented to pull at a 17-degree angle relative to the surface of each chip as it was described in the present invention's specification (page 33, lines 1-16; Figure 2), except that the samples were tested on the lead frame die-bonded to silicon chips via either the prior art film or the novel film respectively. Furthermore, it is noted that each sample was tested at its respective die-bonding temperature for 20 seconds. The results are expressed as the force in kgf per chip required to peel the silicon chip from the lead frame.

Table 1

| Die-bonding Condition | Reason for using the condition | Film | Peel strength (kgf/chip) |
|---------------------------------------|--|---------------|--------------------------------|
| 250°C x 30gf/mm ² x 20 sec | Described in present claims | Morita's film | 0.40 |
| | | Novel film | >6 (All chips destroyed) |
| 250°C x 4gf/mm ² x 2 sec | Described in present claims | Morita's film | 0.03 |
| | | Novel film | 1.15 |
| 230°C x 0.6gf/mm ² x 1 sec | Condition of Example 2 No. 7-10 of the present invention | Morita's film | 0.00 (No adhesion occurred) |
| | | Novel film | 0.55 |

(2) Evaluation of reflow cracks

As described in section 8, subparagraph (1) supra, we used identical die-bonding conditions when die-bonding films and chips. To evaluate the rate of occurrence of reflow cracks, semiconductor devices were fabricated utilizing either the prior art film or the novel film. The method of fabricating the semiconductor devices is that method disclosed

in the specification (page 19, line 25 to page 20, line 21) of the above captioned application, with the exception that the die-bonding was carried out at the conditions specified in Tables I and II of this declaration. After the die-bonding was carried out, the product underwent wire bonding and then molding with an encapsulant material (CEL-9000, Hitachi Chemical Co., Ltd.) to form a semiconductor device. Each semiconductor device was then treated in a thermo-hygrostat at 85°C and 85% relative humidity (RH) for 168 hours, and thereafter heated at 240°C for 10 seconds in an infrared reflow furnace.

The rate of occurrence of reflow cracks was determined by molding each semiconductor device with polyester resin, then cutting each device with a diamond cutter to expose a cross section. Each cross section was observed via a microscope for cracks (referred to as "reflow cracks," specification, page 2, lines 16-19). The rate (%) of occurrence of reflow cracks is defined by the following expression: rate (%) of occurrence of reflow cracks = (number of occurrence of reflow cracks/number of tests) x 100. The test results are presented in Table 2.

Table 2

| Die-bonding Condition | Reason for using the condition | Film | Rate of occurrence of reflow cracks (%) |
|---------------------------------------|--|---------------|---|
| 250°C x 30gf/mm ² x 20 sec | Described in present claims | Morita's film | 100 |
| | | Novel film | 0 |
| 250°C x 4gf/mm ² x 2 sec | Described in present claims | Morita's film | 100 |
| | | Novel film | 0 |
| 230°C x 0.6gf/mm ² x 1 sec | Condition of Example 2 No. 7-10 of the present invention | Morita's film | 100 |
| | | Novel film | 0 |

9. **Discussion of the Results**

The comparative data compiled in Tables 1 and 2 is commensurate in scope with all of the claims because the die-bonding conditions listed in Tables 1 and 2 all fall within the scope of the die-bonding conditions recited in independent claims 17, 19 and 30. Furthermore, each of the tested films in Tables 1 and 2 are made in accordance with the presently claimed invention and include Polyimide F, which was made from DBTA in epoxy resin. Therefore, each of the tested films in Tables 1 and 2 comprise “an organic material selected from the group consisting of epoxy resin and polyimide resin” as recited in independent claims 17, 19 and 30. Lastly, each of the tested films in Table 1 have the property of a “peel strength of 0.5 kgf/(5 mm x 5 mm chip) or higher” as recited in claims 17, 19 and 30. In view of these facts, the experimental data compiled in Tables 1 and 2 has been shown to be commensurate in scope with all of the present claims.

As is clearly shown in Table 1, under each set of die-bonding conditions, the novel film outperformed the areal adhesiveness of Morita's prior art film. Unexpectedly, the areal adhesiveness of the novel film was so great when die-bonded under certain conditions that it could not be fully measured (kfg > 6) by the 17-degree peel strength test used in this experiment because the silicon chips would break before the areal adhesion of the novel film would give way.

As is clearly shown in Table 2, under each set of die-bonding conditions, the novel film outperformed Morita's prior art film in an unexpected way. Specifically, while every one of the semiconductor devices made with the prior art film demonstrated reflow cracks,

none of the semiconductor devices made with the novel film suffered these defects. This result is plainly not a matter of degree, but is a matter of unexpected superiority.

10. **Discussion of Peel Strength**

The peel strength as defined in the present specification, and as used in the claims, was measured using the push-pull gauge oriented to exert a force at an angle of 17 degrees relative to the planar surface of each chip as illustrated in Fig. 2, and as described on page 33, lines 1-16, of the above captioned application. It is clear from the disclosure of the originally filed, above-captioned application, that “peel strength” as used in the specification is a 17-degree peel strength rather than a conventional 90-degree peel strength or a conventional 180-degree peel strength. The “peel strength”, as described and defined in the present application, is a unique test that has advantages over conventional peel strength testing methods for the following reasons.

Specifically, a conventional 90-degree peel strength test, (i.e., “Adhesives – Peel test for a flexible-bonded-to-rigid test specimen assembly” shown in Figure 1 of the International Standard ISO 8510-1:1990(E)), would orient the push-pull gauge so as to exert a force at an angle of 90 degrees relative to the planar surface of the test chip. Conventional 90-degree peel strength is typically measured in units of force per unit length (See Figure 2 of International Standard ISO 8510-1:1990(E)), although the Morita et al. reference reports 90-degree peel strength values in terms of force only (See “Resistance against Peeling” values reported in grams in the Table of U.S. Patent 5,406,124).

A conventional 180-degree peel strength test, (i.e., the “Standard Test Method for Peel or Stripping Strength of Adhesive Bonds” shown in Fig. 2, the Annual Book of ASTM Standards, Designation: D 903-98, 1999), orients the push-pull gauge so as to exert a force at an angle of 180 degrees relative to the planar surface of the test chip. Conventional 180-degree peel strength is typically measured in units of force per length of width (See ASTM Standards, Designation: D 903-98, 1999, section 3.2.2).

I believe that those skilled in the art would know that a 90-degree peel strength test evaluates linear areal adhesive strength whereas a 180-degree peel strength test evaluates shear adhesive strength. On the other hand, the 17-degree peel strength test described on page 33, lines 1-16, and Figure 2, of the above captioned application is a test of oblique or diagonal areal adhesive strength.

The peel strength test described on page 33, lines 1-16, and shown in Figure 2, of the above captioned application, is a different and more efficient test than either of the 90-degree peel strength test and the 180-degree peel test because the invention's 17-degree peel test provides, in a single test, a measurement related to both linear and shear adhesive peel strength properties. However, because there is generally no linear relationship between linear and shear adhesive peel strengths, there is no known conversion factor for converting between linear and adhesive peel strength values (i.e., 90-degree peel strength values and 180-degree peel strength values, respectively). Likewise, there is no known conversion factor for converting between the 17-degree peel strength values according to the definition in the specification, which reflect oblique or diagonal areal adhesion strength, collected in accordance with the method described in the present application, and

either conventional 90-degree peel strength values or conventional 180-degree peel strength values.

There are several reasons for developing the peel strength test described on page 33, lines 1-16, and in Figure 2, of the above captioned application. First, the 17-degree peel strength test according to the invention is more efficient in that a single test provides information regarding both linear and shear adhesive strength properties by testing oblique or diagonal areal adhesive strength. Second, the invention's peel strength test provides information related to the interaction of linear and shear adhesive strength properties by measuring the adhesive strength when an oblique or diagonal force is applied. This adhesive strength measured when an oblique or diagonal force is applied is an oblique or diagonal areal adhesive strength, which should depend upon linear areal adhesive strength, shear adhesive strength and the interaction of linear and shear adhesive strengths of the films. This information is relevant to the advantages of the presently claimed invention, which endeavors to minimize the occurrence of re flow cracks and the detrimental effects on semiconductor packages caused by reflow cracks (See present specification, page 2, line 16, to page 3, line 19). The peel strength test described and defined in the present application measures the oblique/diagonal areal adhesive strength, which is an indirect measure of reflow cracking. The finding that reflow cracks can be prevented by employing a certain minimum value for the oblique/diagonal areal adhesive strength is a new finding unrelated to previously known, conventional linear and shear adhesive strengths of organic die-bonding films.

Lastly, choosing force per area as the representational units for measurements of areal adhesion strength tested in the above captioned application, using the 17-degree peel

strength test, was done as a matter of convenience. Specifically, the push-pull gauge measures force in kg force units and each test chip had an area of 5 mm x 5 mm. Therefore, reporting oblique/diagonal areal adhesive strength in terms of kg of force per 5 mm x 5 mm chip area was the simplest way to report the measured values. I believe that a person skilled in the art would realize that the 17-degree peel strength test method described and defined in the above captioned application is a unique test, and that our choice of units are acceptable and useful so long as we use them uniformly throughout our comparative testing.

11. **Conclusions**

I believe the comparative testing compiled in Tables 1 and 2 above reasonably support the following conclusions. First, the data collected in Tables 1 and 2 is commensurate in scope with the presently claimed invention. Second, the oblique/diagonal areal adhesive strength of the films made in accordance with the presently claim invention, as measured by peel strength testing reported in Table 1, is unexpectedly superior to the oblique/diagonal areal adhesive strength of the Morita film representing the closest prior art. Third, the absence of reflow cracking of films made in accordance with the presently claimed invention compared to the presence of reflow cracking of the Morita film representing the prior is another unexpected and superior characteristic of the films of the present invention.

Lastly, I believe that my testimony establishes the rationale for the 17-degree peel strength test described and defined on page 33, lines 1-16, and Figure 2, of the above captioned application. I believe that a person skilled in the art would realize that the 17-degree peel strength test, while not a conventional test, provides valuable information

regarding oblique/diagonal areal adhesive strength properties of organic die -bonding films in a manner that is suitable for comparative testing.

12. I declare under penalty of perjury that the foregoing is true and correct, that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Signed by,

Date: Apr. 8, 2004

Takashi Masuko
MASUKO Takashi